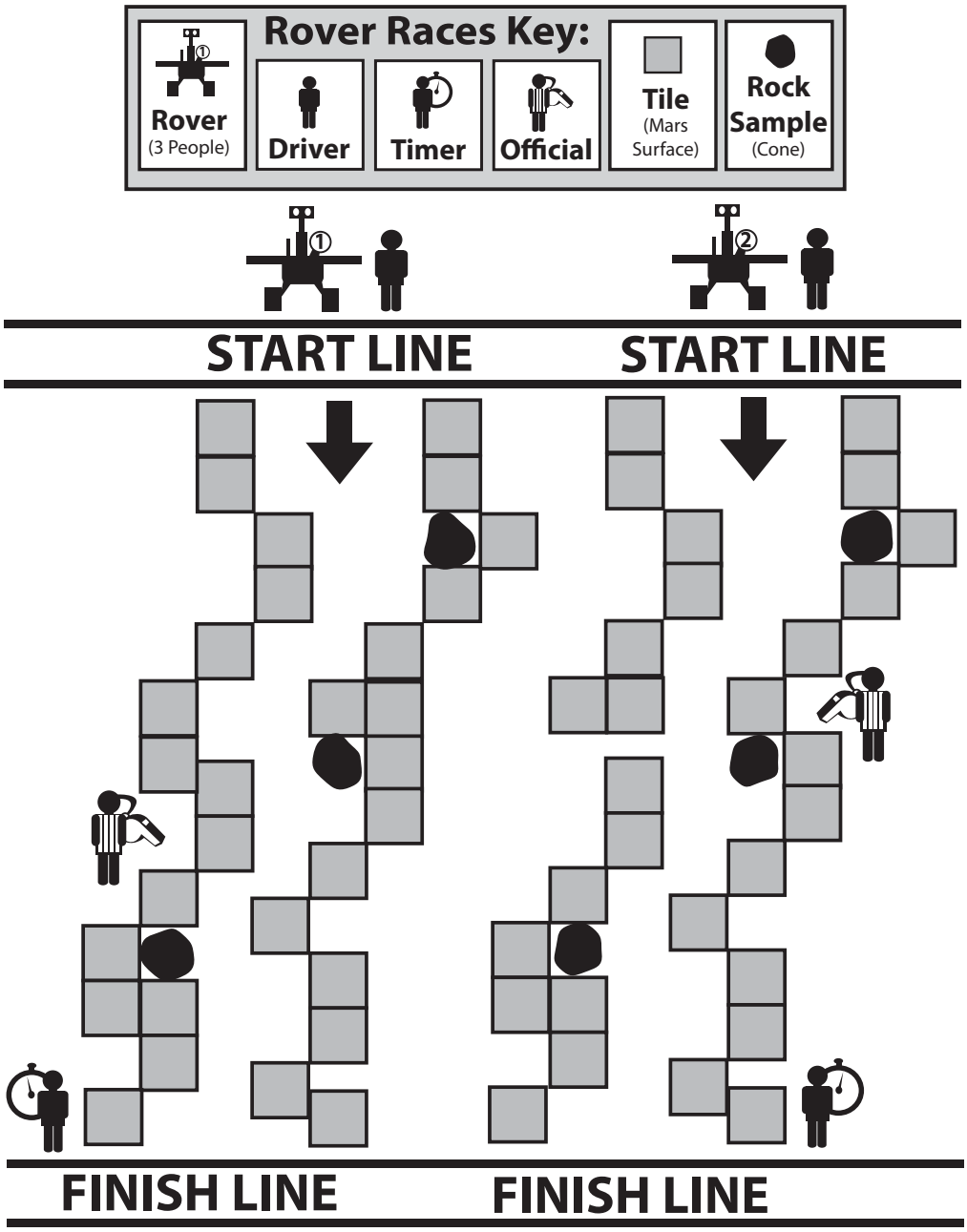
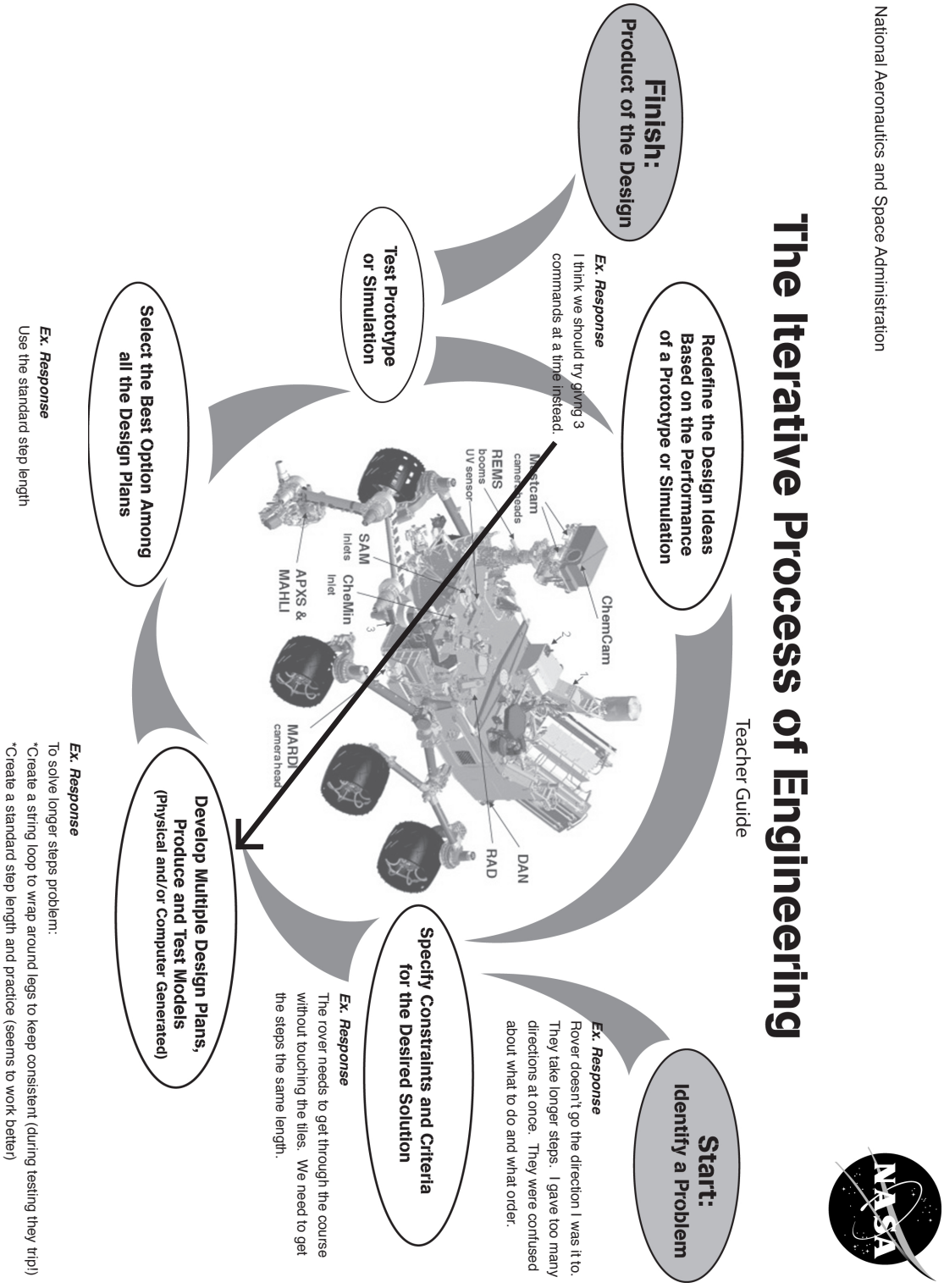
(G) Teacher Resource. Course Set Up Example



(H) Teacher Resource. Iterative Process of Engineering



(I) Teacher Resource. Rover Races Rubric (1 of 2)

You will know the level to which your students have achieved the **Learning Outcomes**, and thus the **Instructional Objective(s)**, by using the suggested **Rubrics** below.

Instructional Objective 1: To produce an engineering design that meets goals within constraints

Related Standards (will be replaced when new NRC Framework-based science standards are released):

National Science Education Standards (NSES)
(E) Science and Technology: Abilities of Technological Design

Grades 5-8:

(E1b) Design a Solution or Product. Students should make and compare different proposals in light of the criteria they have selected. They must consider constraints—such as cost, time, trade-offs, and materials needed—and communicate ideas with drawings and simple models.

(E1c) Implement a Proposed Design. Students should organize materials and other resources, plan their work, make good use of group collaboration where appropriate, choose suitable tools and techniques, and work with appropriate measurement methods to ensure adequate accuracy.

(E1d) Evaluate completed technological designs or products. Students should use criteria relevant to the original purpose or need, consider a variety of factors that might affect acceptability and suitability for intended users or beneficiaries, and develop measures of quality with respect to such criteria and factors; they should also suggest improvements, and for their own products, try proposed modifications.

National Science Education Standards (NSES)
(E) Science and Technology: Understandings About Science & Technology

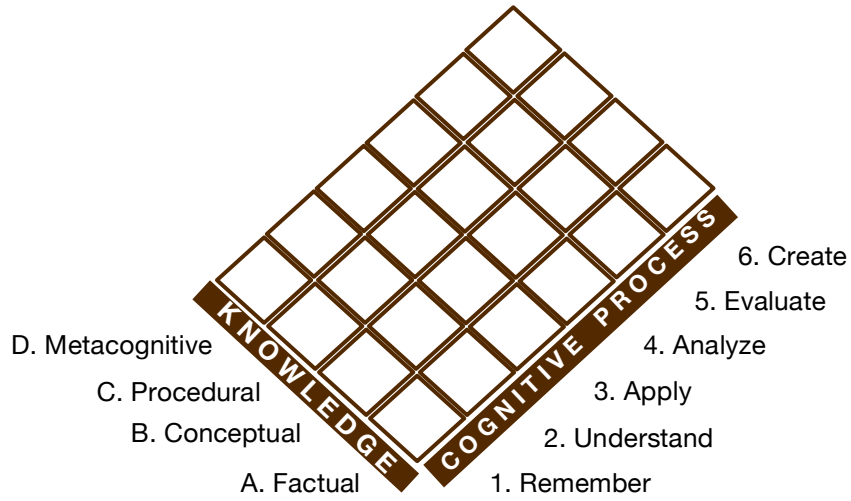
Grades 5-8:

(E2e) Technological designs have constraints. Some constraints are unavoidable, for example, properties of materials or effects of weather and friction; other constraints limit choices in the design, for example, environmental protection, human safety, and aesthetics.

Related Rubrics for the Assessment of Learning Outcomes Associated with the Above Standard(s):

Learning Outcome	Expert	Proficient	Intermediate	Beginner
LO1a: to identify limitations in an engineering design (rover command sequence)	Analysis is highly accurate and complete.	Analysis is accurate and complete.	Analysis is somewhat accurate and complete.	Analysis is not accurate or complete.
LO1b: to generate solutions by setting new requirements to improve engineering design (command sequence)	Requirements are highly detailed and precise.	Requirements are detailed and precise.	Requirements are somewhat detailed and precise.	Requirements are not detailed or precise.
LO1c: to test an engineering design	Tests result in significant improvement in design (goal achievement in completing the course).	Tests result in improvement in design (goal achievement in completing the course).	Tests result in moderate improvement in design (goal achievement in completing the course).	Tests do not result in improvement.
LO1d: to evaluate an engineering design (acceptable rover commands to complete a course)	Evaluation is highly clear and complete, with design changes well documented and thoughtful.	Evaluation is clear and complete, with design changes documented and thoughtful.	Evaluation is mostly clear and complete, with design changes documented. .	Evaluation is not clear and complete, with design changes not well documented.

(J) Alignment of Instructional Objective(s) and Learning Outcomes with Knowledge & Cognitive Process Types (1 of 3)

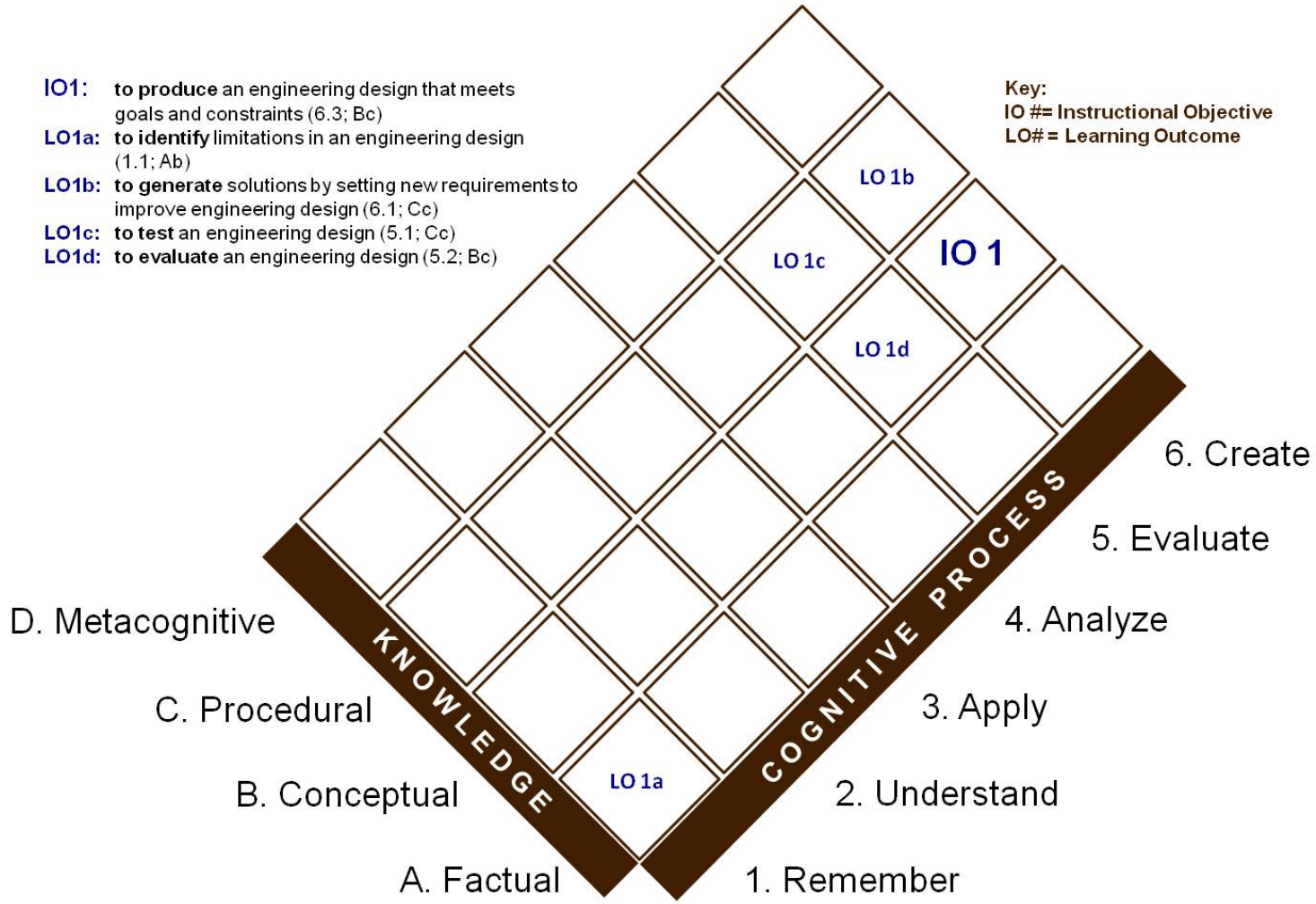


This lesson adapts Anderson and Krathwohl's (2001) taxonomy, which has two domains: Knowledge and Cognitive Process, each with types and subtypes (listed below). Verbs for objectives and outcomes in this lesson align with the suggested knowledge and cognitive process area and are mapped on the next page(s). Activity procedures and assessments are designed to support the target knowledge/cognitive process.

Knowledge	Cognitive Process
A. Factual **Aa:** Knowledge of Terminology **Ab:** Knowledge of Specific Details & Elements **B. Conceptual** **Ba:** Knowledge of classifications and categories **Bb:** Knowledge of principles and generalizations **Bc:** Knowledge of theories, models, and structures **C. Procedural** **Ca:** Knowledge of subject-specific skills and algorithms **Cb:** Knowledge of subject-specific techniques and methods **Cc:** Knowledge of criteria for determining when to use appropriate procedures **D. Metacognitive** **Da:** Strategic Knowledge **Db:** Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge **Dc:** Self-knowledge	**1. Remember** **1.1** Recognizing (Identifying) **1.2** Recalling (Retrieving) **2. Understand** **2.1** Interpreting (Clarifying, Paraphrasing, Representing, Translating) **2.2** Exemplifying (Illustrating, Instantiating) **2.3** Classifying (Categorizing, Subsuming) **2.4** Summarizing (Abstracting, Generalizing) **2.5** Inferring (Concluding, Extrapolating, Interpolating, Predicting) **2.6** Comparing (Contrasting, Mapping, Matching **2.7** Explaining (Constructing models) **3. Apply** **3.1** Executing (Carrying out) **3.2** Implementing (Using) **4. Analyze** **4.1** Differentiating (Discriminating, distinguishing, focusing, selecting) **4.2** Organizing (Finding coherence, integrating, outlining, parsing, structuring) **4.3** Attributing (Deconstructing) **5. Evaluate** **5.1** Checking (Coordinating, Detecting, Monitoring, Testing) **5.2** Critiquing (Judging) **6. Create** **6.1** Generating (Hypothesizing) **6.2** Planning (Designing) **6.3** Producing (Constructing)

(J) Alignment of Instructional Objective(s) and Learning Outcomes with Knowledge & Cognitive Process Types (2 of 3)

The design of this activity leverages Anderson & Krathwohl's (2001) taxonomy as a framework. Pedagogically, it is important to ensure that objectives and outcomes are written to match the knowledge and cognitive process students are intended to acquire.



(J) Alignment of Instructional Objective(s) and Learning Outcomes with Knowledge & Cognitive Process Types (3 of 3)

The design of this activity leverages Anderson & Krathwohl's (2001) taxonomy as a framework. Below are the knowledge and cognitive process types students are intended to acquire per the instructional objective(s) and learning outcomes written for this lesson. The specific, scaffolded 5E steps in this lesson (see 5.0 Procedures) and the formative assessments (worksheets in the Student Guide and rubrics in the Teacher Guide) are written to support those objective(s) and learning outcomes. Refer to (J, 1 of 3) for the full list of categories in the taxonomy from which the following were selected. The prior page (J, 2 of 3) provides a visual description of the placement of learning outcomes that enable the overall instructional objective(s) to be met.

At the end of the lesson, students will be able

IO1: to produce an engineering design

6.3: to produce

Bc: knowledge of theories, models, and structures

To meet that instructional objective, students will demonstrate the abilities:

LO1a: to identify limitations

1.1: to identify

Ab: knowledge of specific details and elements

LO1b: to generate proposed solutions

6.1: to generate

Cc: knowledge of criteria for determining when to use appropriate procedures

LO1c: to test an engineering design

5.1: to test

Cc: knowledge of criteria for determining when to use appropriate procedures

LO1d: to evaluate an engineering design

5.2: to judge with criteria

Bc: knowledge of theories, models, and structures